

Perception, with focus on Vision

And some other stuff too....

We know the world because we have five senses that pick up information about it and present it to the mind.



We can improve on this story

False because (I):

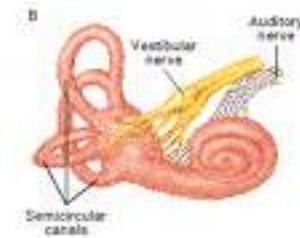
Sensory data comes from at least the following systems:



audition



vision



vestibular
system



proprioception
and kinaesthesia



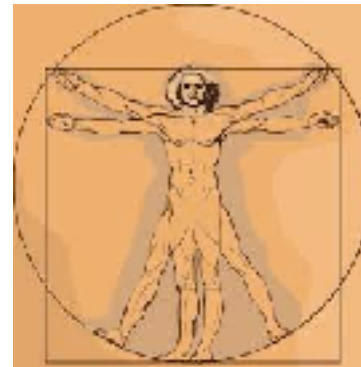
touch
pain
heat/cold
vibration



taste



olfaction



interoception

Touch is more than one thing:

Sensitivity to temperature (thermoception)

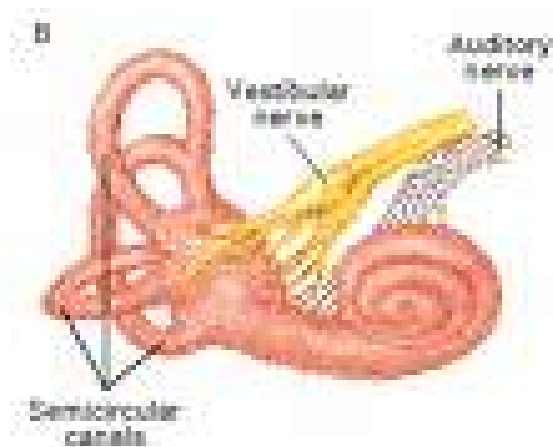
Awareness of pain (nociception)

Receptors sensitive to skin stretch

Receptors sensitive to vibration.

Receptors sensitive to pressure

So touch is a bundle of sensory modalities!



vestibular system

Organ: semi-circular canals in the inner ear

Awareness of balance and spatial orientation of the body — where are you with respect to the world

Works closely with visual system, helping to stabilise eyes when the head is moved

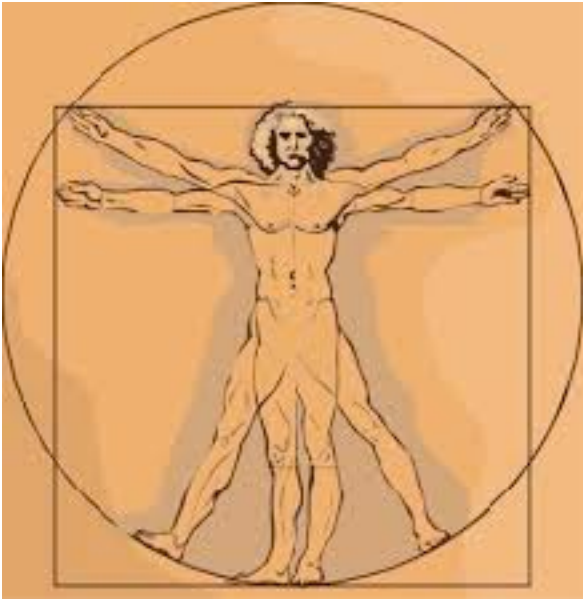


proprioception and kinaesthesia

Proprioception: awareness of the relative position of body parts

Kinaesthesia: awareness of movement through space

Both linked to receptors in joints and muscles



interoception: awareness of the physiological state of the body

Are you nauseous? Feeling hungry?

Many different kinds of receptors related to condition of digestive system, respiratory system, hormonal system, etc.

Not one simple sensory modality.

False because (2):

You come to know the world around you by *actively* exploring, *seeking* and *generating* sensory information through guided action.

Perception is not a passive process.

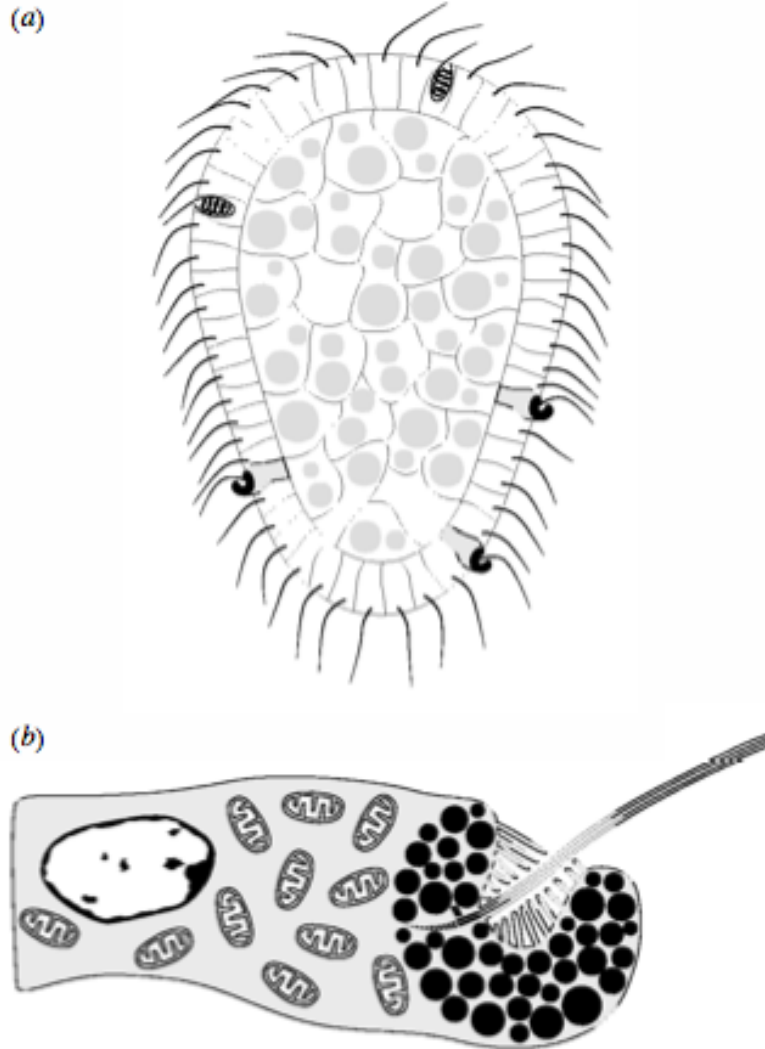
Vision

Vision is **for** something

Guiding action

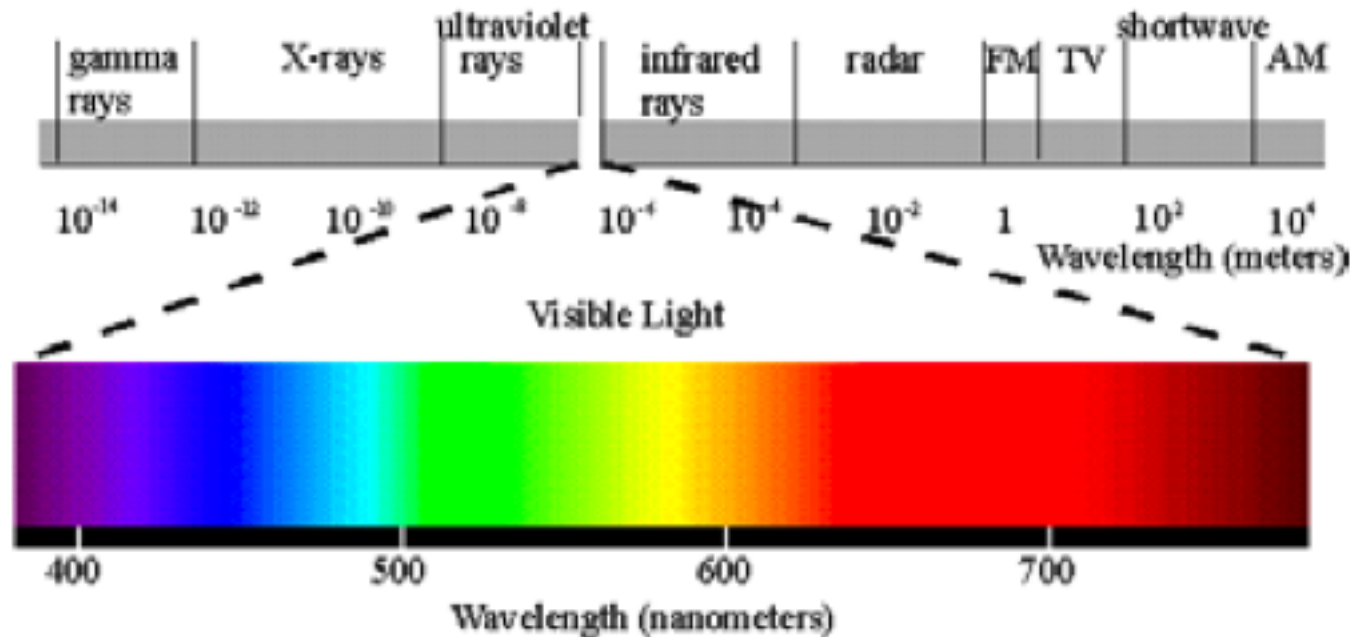
Locating resources (food, mates, predators)

What's the simplest visual system we could imagine?

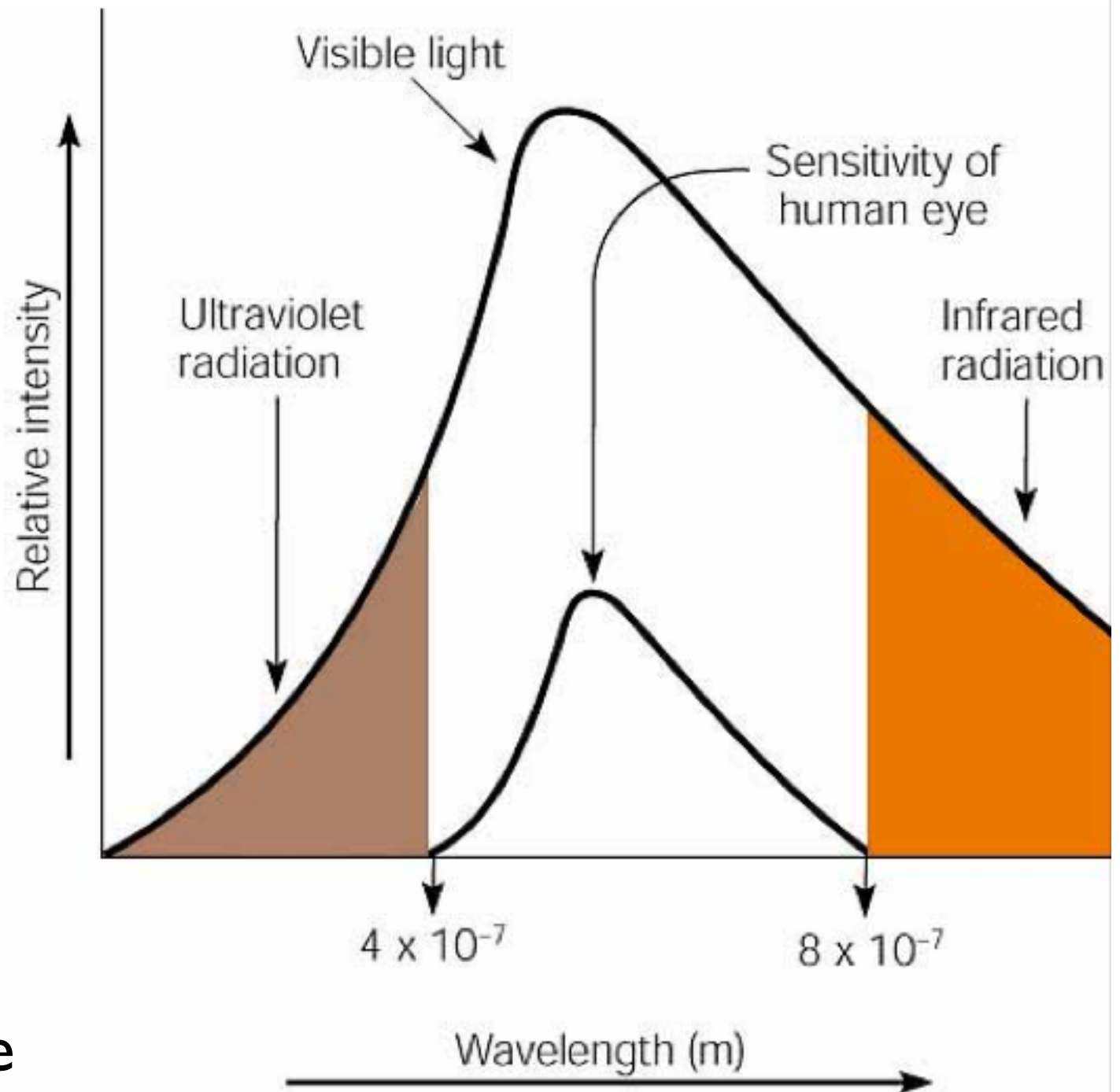


Tripedalia cystophora, a jellyfish larva, has 2 tissue types, 5 cell types and no nervous system. Photoreceptors in special cells, the ocelli, directly alter the direction of tiny hairs within the photoreceptor cell. These hairs steer the otherwise uncontrolled motion of the larvae.

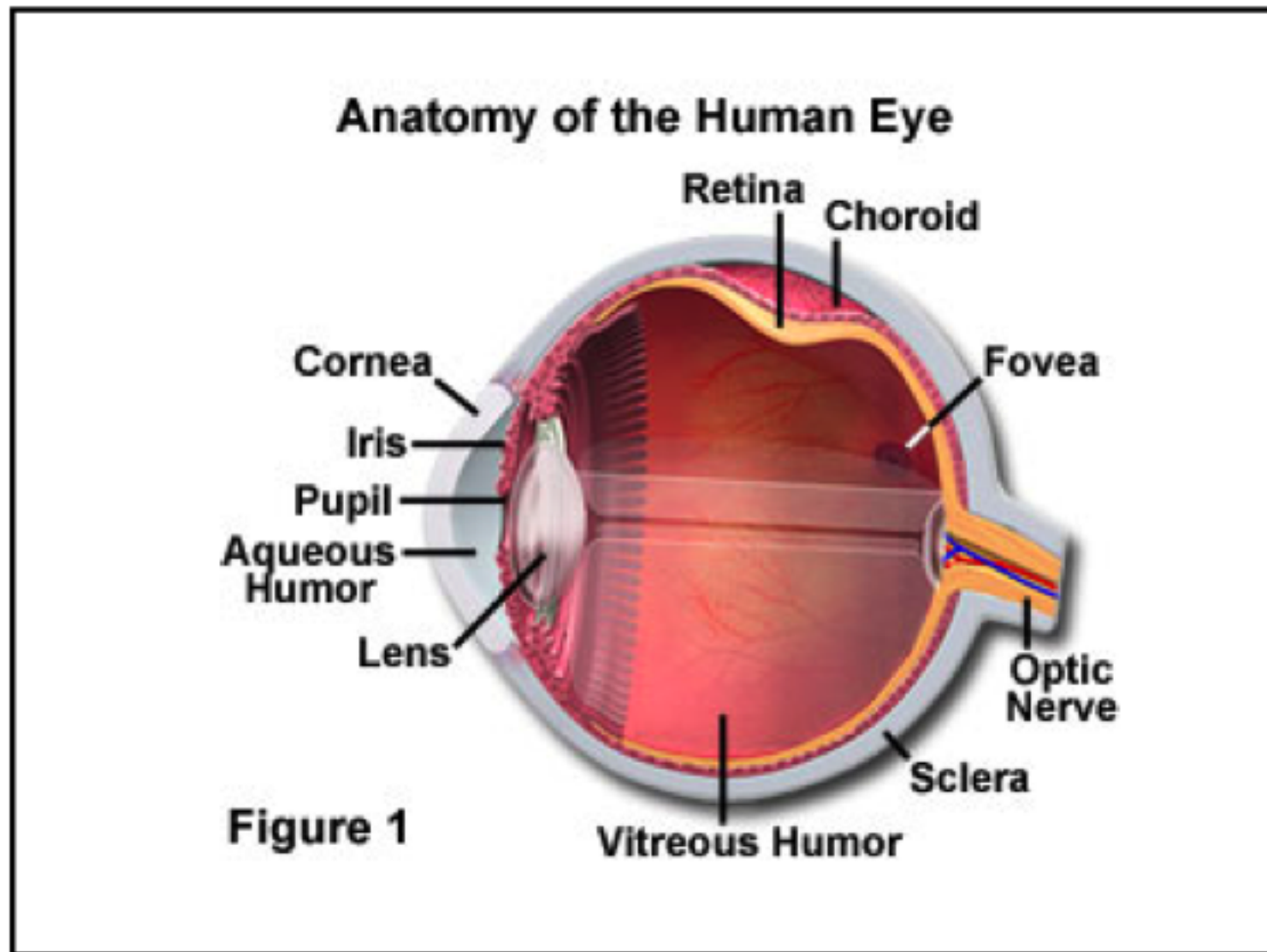
Electromagnetic Spectrum



Most of
the radiation in
raw sunlight is
invisible
to the human eye



The eye: one component in the visual system.

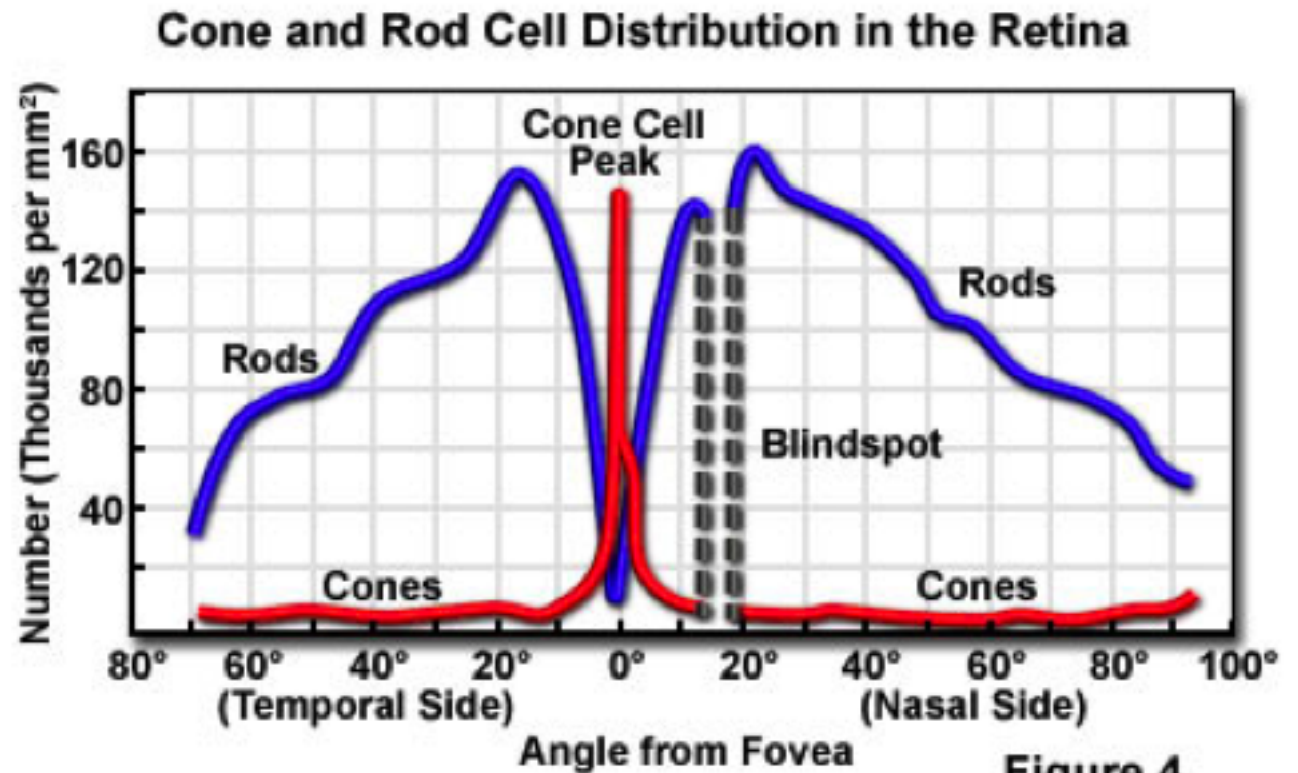


150 Million
Rods

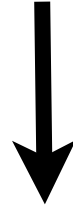
7 Million
Cones

1 Million
Nerve Fibres

Distribution of rods and cones



eye



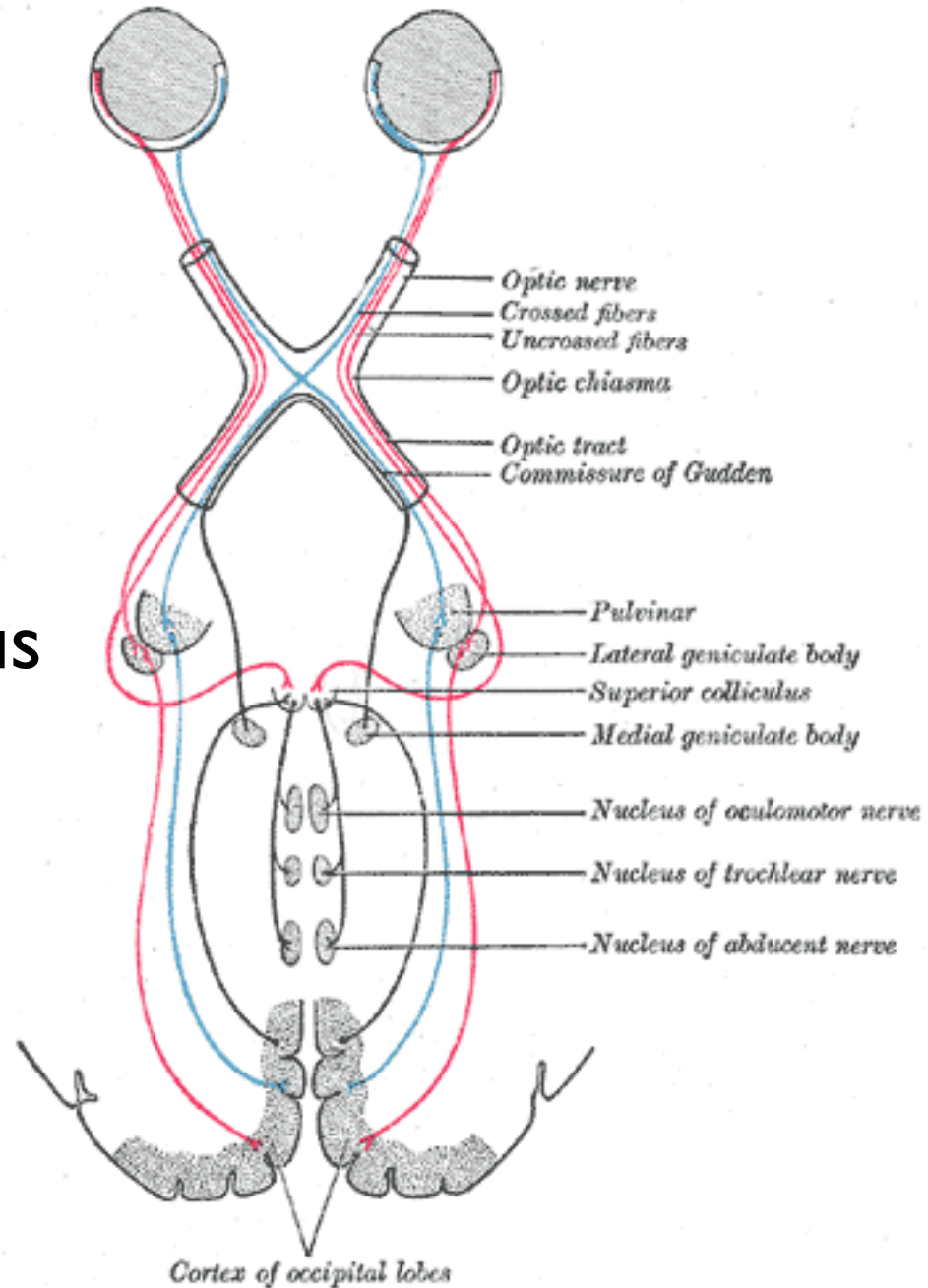
optic chiasma

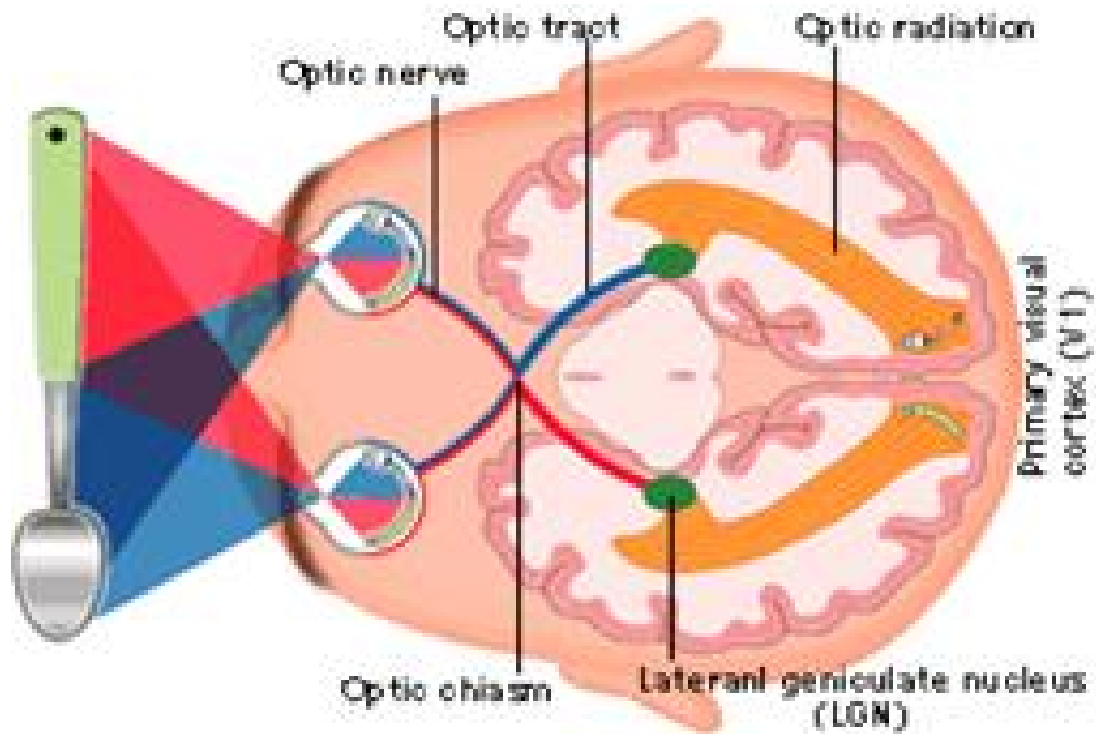


lateral geniculate nucleus

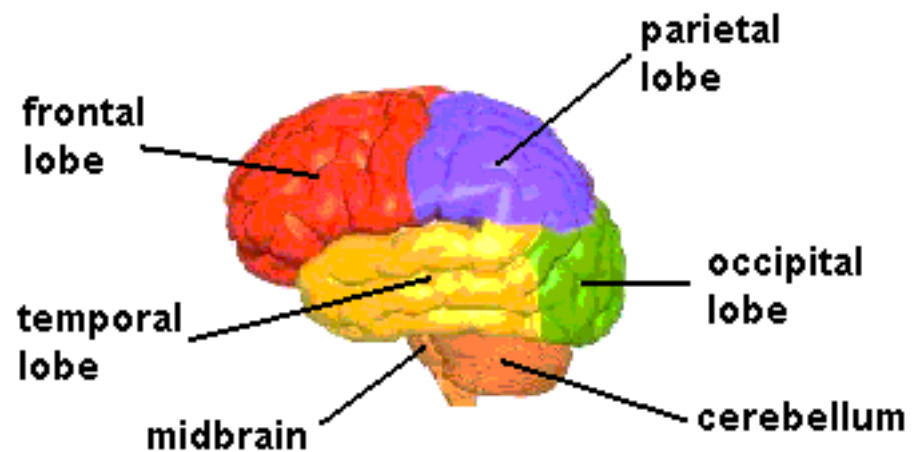


visual cortex

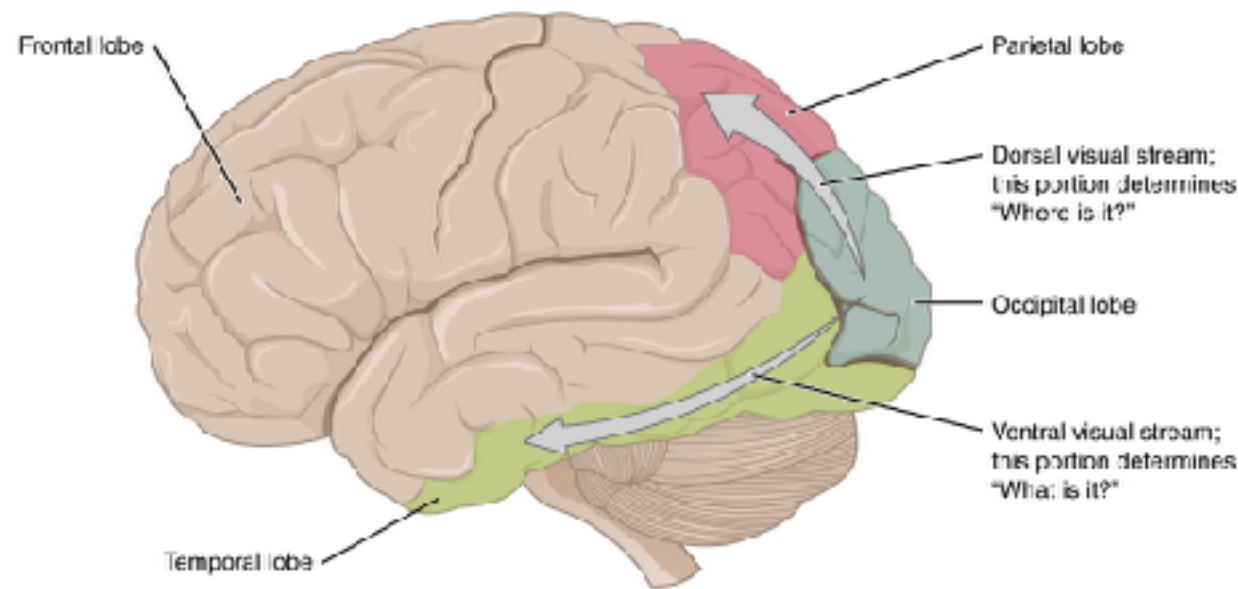




Lobes of the cerebral cortex

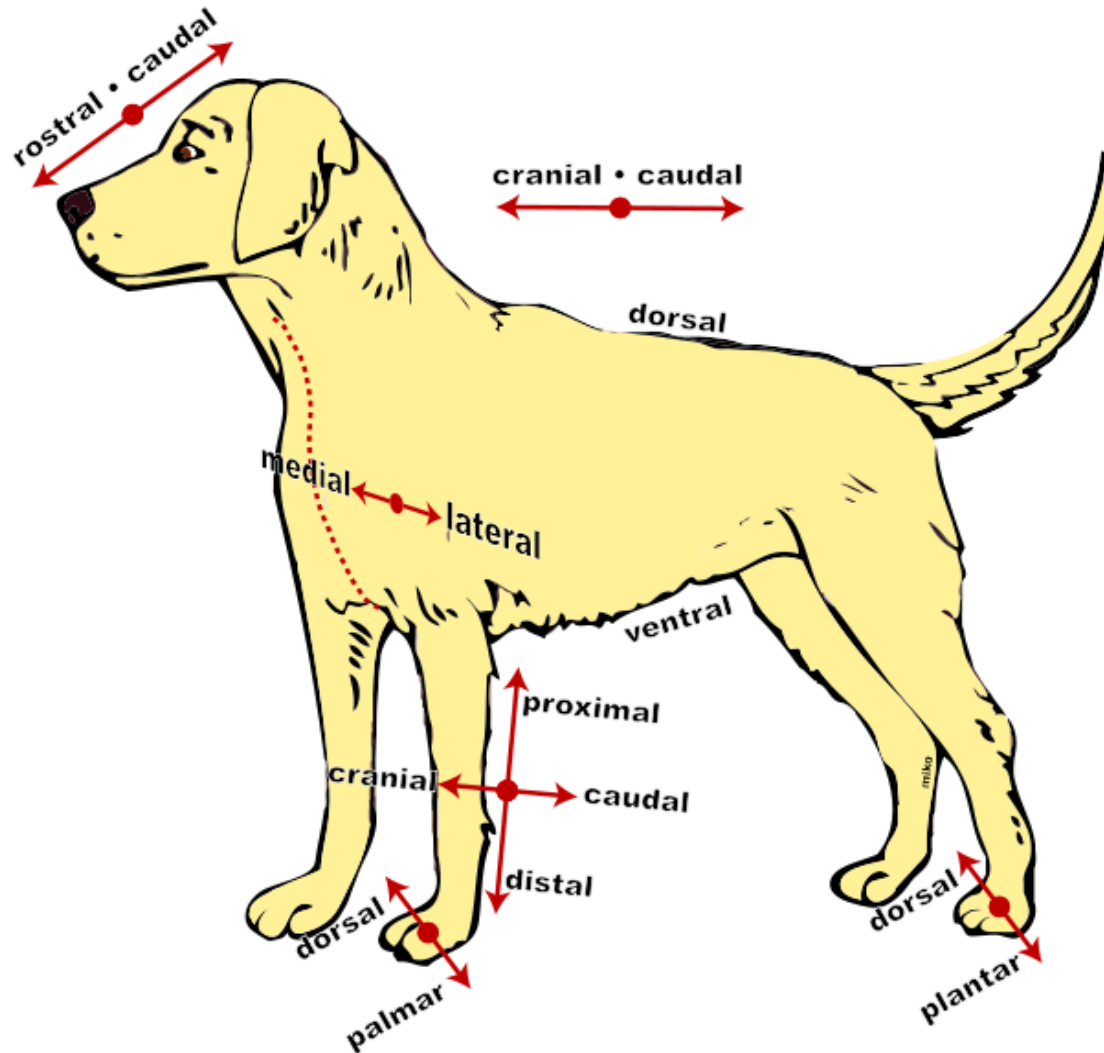


After the primary visual area (V1), visual processing continues in 2 major pathways: the *dorsal stream* and the *ventral stream*.



At each stage of processing, more information is combined, incorporating high-level knowledge, expectations, information from other modalities, etc

Your handy guide to anatomical reference adjectives (for reference purposes. You don't need to learn all this)



Ventral - the underside

Dorsal - the back of the animal; the side opposite the ventral side. The vertebral column of vertebrates is on the dorsal side of the animal.

Lateral - toward the side

Median - toward the middle

Anterior - the head end

Posterior - the end opposite the head end

Caudal - toward the tail

Cranial - toward the head

Longitudinal - along a line from the head to the tail

Transverse - along a line that is 90° to the longitudinal axis (see above)

Superficial - shallow

Pectoral - toward the forelimbs

Pelvic - toward the rear limbs

Distal - far from

Proximal - near

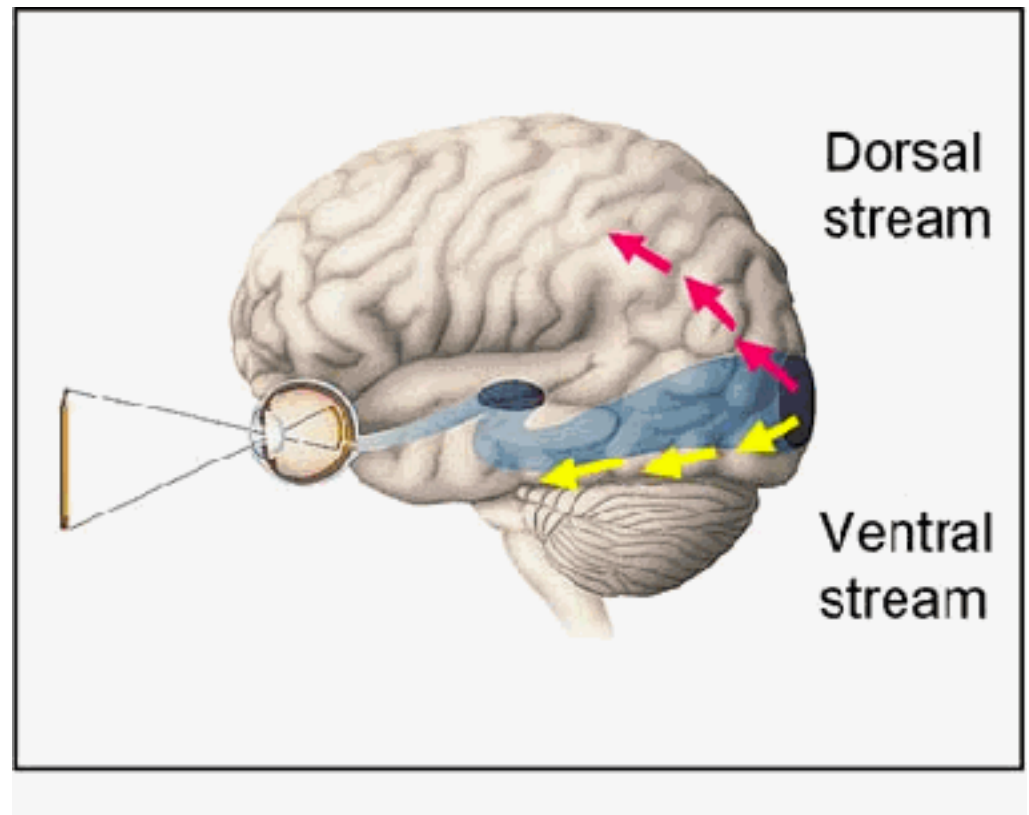
The Dorsal Stream (red arrows)

The “WHERE” stream

Keeping track of multiple objects

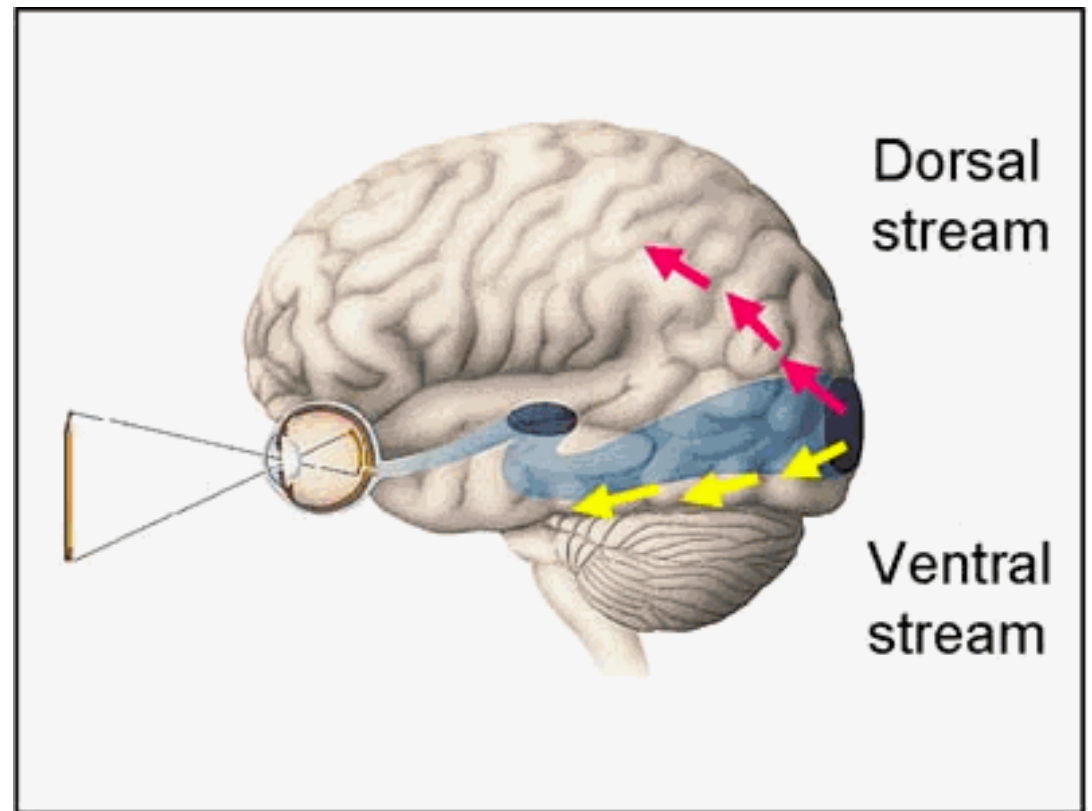
Relating your movements to your environment

Guiding action



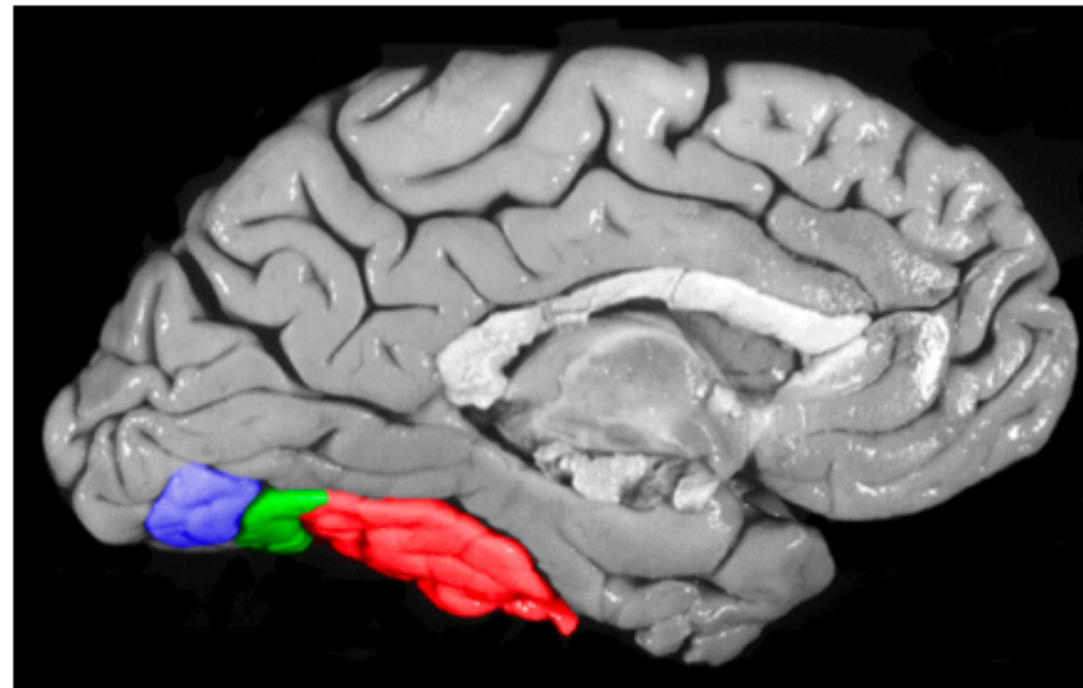
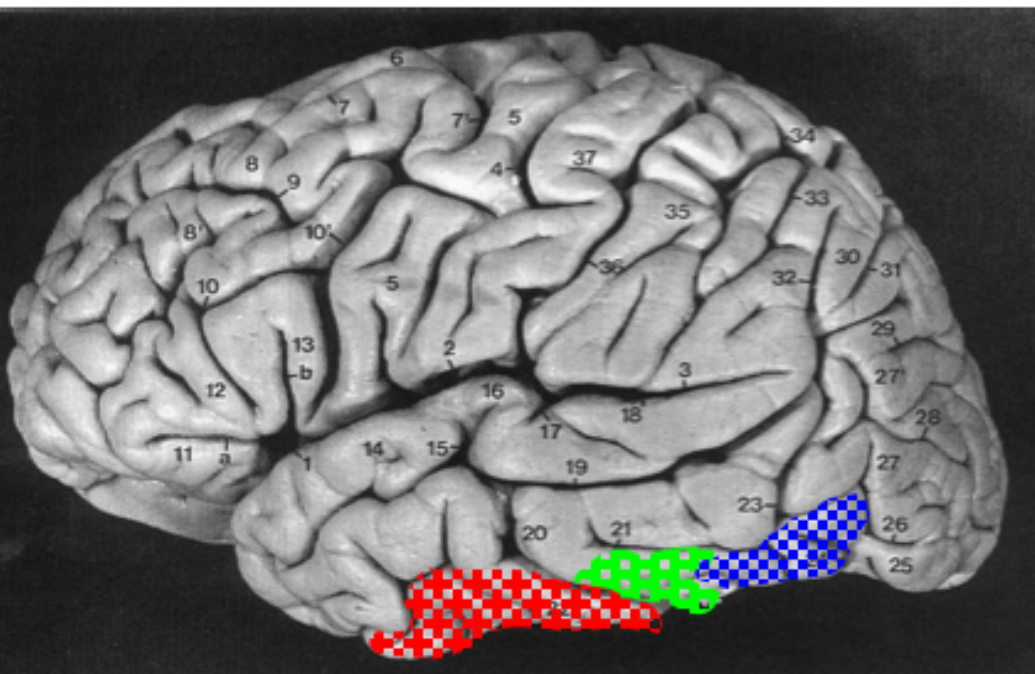
The Ventral Stream (yellow arrows)

The “WHAT” stream
Object recognition
Face recognition



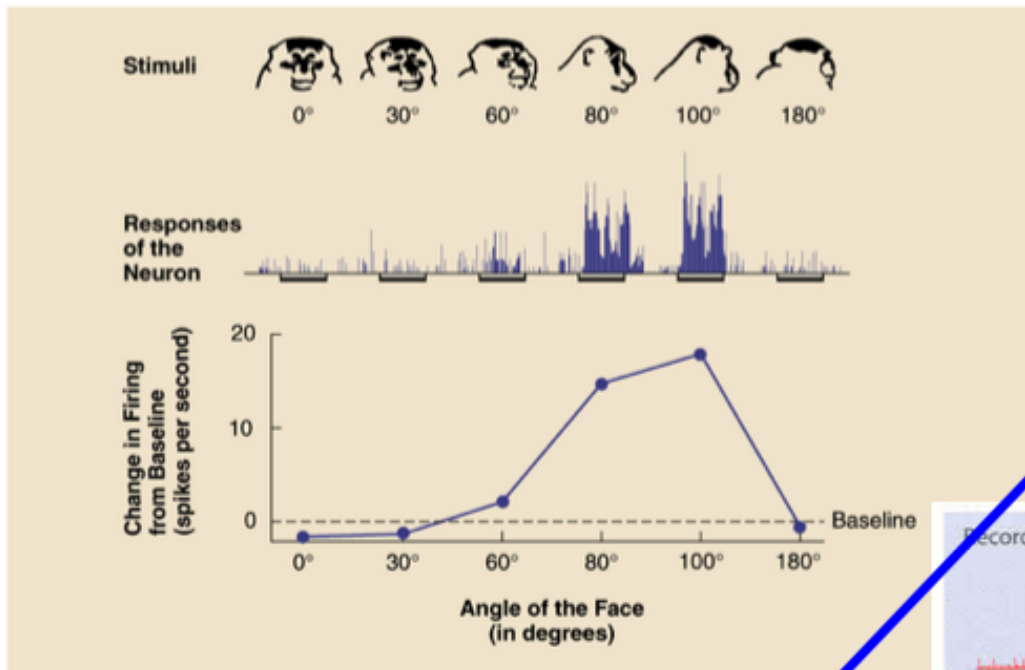
Some Neurophysiology

- The inferotemporal cortex (IT) contains neurons that respond selectively to particular objects, or complex shapes
 - like bananas or a circle with a T shape attached to it - different studies find different sensitivities.

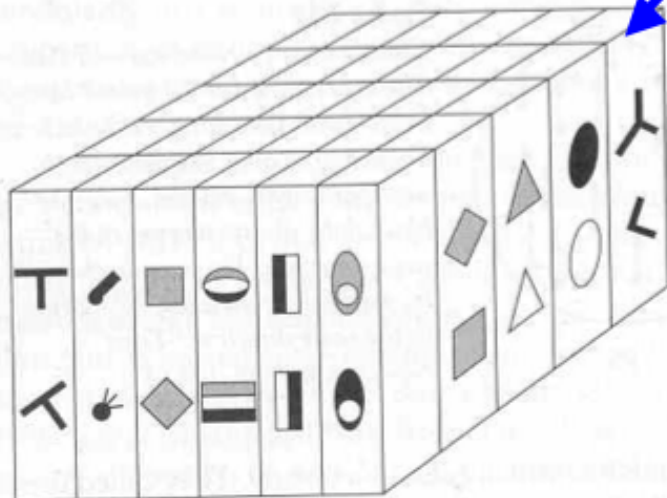


Tuning in monkey IT

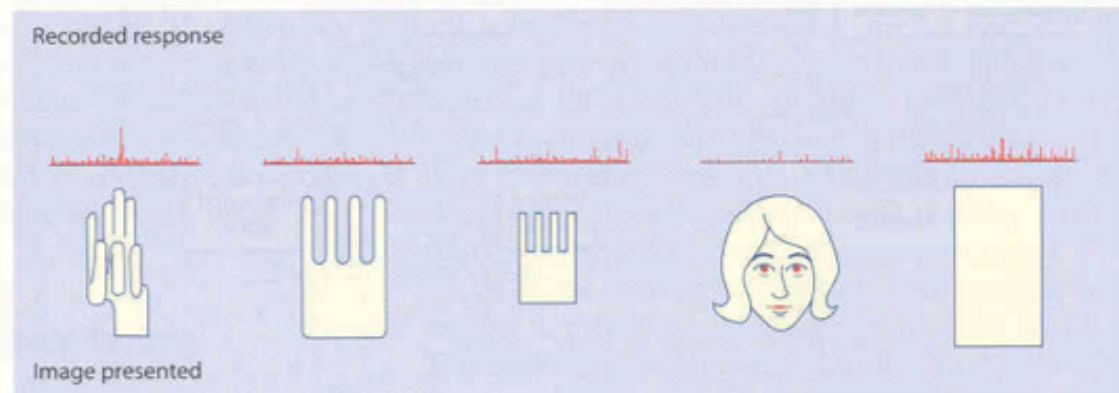
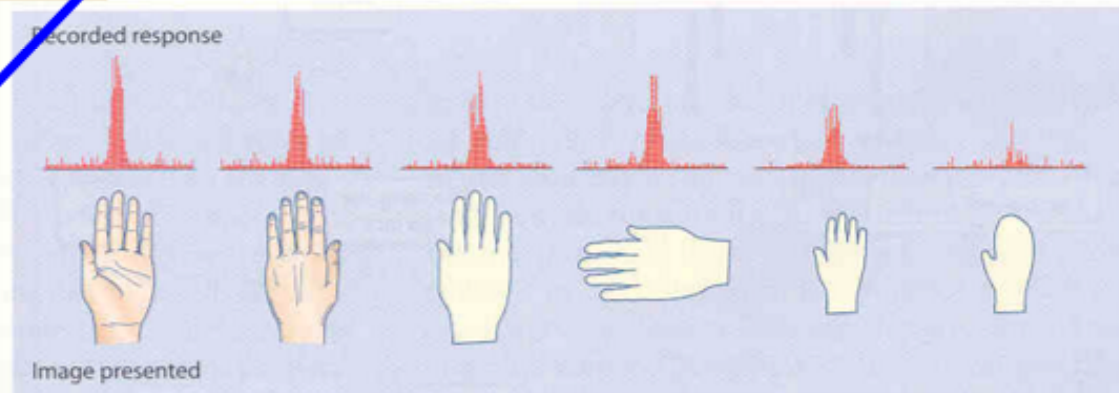
► Firing Rate of a Monkey Inferotemporal Cortex Neuron



Source: Adapted from Gross et al., *Pattern Recognition Mechanisms*, p. 179-201. Berlin: Springer-Verlag 1985.



Cells respond to specific stimuli
And are clustered into columns with similar tuning



As we ascend the processing pathways, cells are selectively responsive to more and more abstract properties

Nobody has yet found the “Grandmother Cell”

...But some cells are very specific to high-order properties of the input.. e.g. face specificity

Illustration of the
Thatcher effect
(so named as the
first face used was
of Margaret
Thatcher)



The effect does not
go away with repeated
viewing





Mirror Neurons

Nerve cells have been found in monkeys, which fire when the monkey sees a *specific, goal-directed* action. They also fire when the monkey does that action itself.

Humans are believed to have these *mirror neurons* too. For some scientists, they seem to represent a *direct link between perception and action* (remember the jellyfish larva?).

Much speculation ensues.....



Mirror neurons

(Please don't call them monkey-see/monkey-do neurons)

If you believe perception and action are always inseparable ... (as many scientists do)

...mirror neurons look like what you might expect to find in a nervous system.

If you see perception as entirely distinct from action ... (as many other scientists do)

mirror neurons look like a hugely important special-purpose neural device responsible for all kinds of things

Scientists don't always agree.

Those who see mirror neurons as hugely important, have linked them to:

- * a possible basis for autism
- * a possible basis for empathy
- * a possible basis for the evolution of tool use
- * a possible basis for the evolution of language
- * a possible basis for our enjoyment of sport (etc)

They may seem to allow a way to relate your experience to the experience of another person

Those who don't, don't.